CHEMISTRY

Paper 5070/11
Multiple Choice

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**B**
2	**B**	22	**A**
3	**B**	23	**C**
4	**D**	24	**B**
5	**C**	25	**A**
6	**D**	26	**B**
7	**C**	27	**C**
8	**D**	28	**B**
9	**D**	29	**D**
10	**B**	30	**B**
11	**D**	31	**C**
12	**C**	32	**A**
13	**C**	33	**C**
14	**B**	34	**D**
15	**A**	35	**D**
16	**A**	36	**C**
17	**A**	37	**D**
18	**A**	38	**A**
19	**D**	39	**C**
20	**B**	40	**C**

General Comments

There was sound subject knowledge shown in many questions on the paper. Candidates should be reminded to read the question and all of the options carefully before selecting their response to multiple choice questions.

Comments on Specific Questions

Question 9

Although stronger candidates gave the correct answer of **D**, a significant percentage of other candidates selected option **B**. This comes from giving the number of covalent bonds rather than considering the number of electrons involved in the bonds.

Question 17

Candidates generally knew which energies are involved in the activation energy compared with those that are involved the enthalpy change of reaction. This meant that the vast majority of candidates realised that H_3 was involved but many thought that H_2 was also involved. Stronger candidates gave the correct answer **A** by using H_1.

Question 19

This question proved challenging for many candidates who did not realise that as the amount of water is reduced by electrolysis, the sulfuric acid concentration increases.

Question 21

The better candidates were able to assess each statement to decide which one was **not** correct.

Question 35

Although the vast majority of candidates knew that hydrogen and nitrogen were not involved in the linkage in starch, a significant number thought that carbon was and so gave **A** as the answer rather than **D**.

Question 36

Candidates recognised that **A** was a polyester and most also recognised that **D** was not formed by condensation polymerisation. Distinguishing between the other two polymers proved more challenging with only the strongest candidates giving the correct answer of **C**. It appears likely that candidates ignored the carbon atom in the amide linkage when deciding on the number of carbon atoms in the monomer.

Question 39

A significant number of candidates selected option **B**, thinking that ammonia was used to make nitrogen and hydrogen industrially, perhaps having been distracted by the equilibrium sign in the equation.

CHEMISTRY

Paper 5070/12
Multiple Choice

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**C**
2	**B**	22	**C**
3	**A**	23	**D**
4	**C**	24	**B**
5	**C**	25	**A**
6	**B**	26	**C**
7	**D**	27	**C**
8	**B**	28	**D**
9	**D**	29	**C**
10	**D**	30	**C**
11	**B**	31	**A**
12	**A**	32	**B**
13	**B**	33	**C**
14	**B**	34	**D**
15	**A**	35	**A**
16	**B**	36	**A**
17	**B**	37	**C**
18	**A**	38	**C**
19	**B**	39	**B**
20	**A**	40	**D**

General Comments

There was sound subject knowledge shown in many questions on the paper. Candidates should be reminded to read the question and all of the options carefully before selecting their response to multiple choice questions.

Comments on Specific Questions

Question 10

The strongest candidates were able to answer this question correctly. The most common incorrect answer was **B**. Candidates selecting **B** did not take into account that each methane molecule contains four hydrogen atoms.

Question 14

This question proved very challenging with only the best candidates giving the correct option of **B**. Option **A** was very attractive suggesting that most candidates associate the production of a white precipitate by tap water with the addition of aqueous silver nitrate.

Question 18

This question proved challenging for many candidates with **D** proving the most attractive of the incorrect answers.

Questions 24

Only the strongest candidates answered this question correctly. The question required candidates to assess each statement to decide which was not correct and many candidates incorrectly chose option **A**. Candidates should be reminded to read all options given carefully, particularly where a question asks for the statement which is **not** true to be identified.

Question 28

Many candidates gave the correct response, **D**, to show that catalysts are used in all these industrial processes. The popularity of other responses showed that many candidates recognised the significance of some, but not all, the reactions.

Question 38

Many candidates gave the correct answer, **C**, showing that they recognised that there were five correct statements about ethanol. Only a minority thought that all six statements were correct whilst a significant number identified four of the five as correct.

CHEMISTRY

Paper 5070/21
Theory

Key Messages

To be successful in calculations candidates must organise their answers in a clear and coherent way making certain that the working out is clearly shown.

General Comments

Candidates often could not balance chemical equations, and should take care to use correct formulae.

Candidates should ensure they have a clear understanding of the kinetic theory of matter as often they described bulk properties rather than what happens to the particles.

Candidates did not always organise their answers to quantitative questions which made it difficult to give credit for errors carried forward. Candidates should be advised to show all the steps in a calculation so that the working out can still be credited when an answer is incorrect.

Comments on Specific Questions

Section A

Question A1

(a) Many candidates recognised that argon occupied about 1% by volume of air. A common error was to give carbon dioxide.

(b) Most candidates recognised that chlorine was a gas that bleaches moist litmus paper. Only a small number of candidates gave sulfur dioxide which was also a correct answer. The most common incorrect answer given was to give ammonia.

(c) Many candidates recognised ammonia as a gas that forms an alkaline solution.

(d) Many candidates recognised ethene as a gas that can be polymerised. Some candidates did not write their answers clearly enough to tell if the answer given was ethene or ethane.

(e) Candidates often chose oxygen but a common incorrect response was sulfur dioxide.

Question A2

(a) The 'dot-and-cross' diagram for ammonia was well known by candidates and there were very few examples of ionic structures. Weaker candidates forgot to include the lone pair on the nitrogen atom.

(b) Some candidates found drawing the structure of propyl ethanoate challenging. Many candidates did not give an ester and those that did, often gave ethyl propanoate instead. Candidates were more likely to give the correct name for the ester rather than the correct structure.

(c) Many candidates could calculate the empirical formula as C_6H_6O. An error frequently seen was to use the wrong relative atomic masses with some candidates using 32 for oxygen and 2 for hydrogen. Other candidates used the atomic numbers instead of the relative atomic mass. Another error was to divide the relative atomic mass by the percentage.

(d) (i) Some candidates identified the gas as sulfur dioxide but were unable to describe the formation of acid rain. Most candidates only referred to sulfur dioxide dissolving or reacting with water and did not include an oxidation stage. Many candidates did not appreciate that acidified potassium manganate(VII) is used to test for sulfur dioxide and gave the gas as carbon monoxide or various oxides of nitrogen.

(ii) Many candidates did not give accurate descriptions of the effect of acid rain on buildings and referred to corrosion of limestone rather than the erosion. If candidates referred to corrosion they needed to refer to a metal in their answer.

(iii) Some candidates gave a word equation rather than a symbol equation for respiration. Other candidates included energy or ATP in their equation and in these cases the balanced equation did not gain full credit.

Question A3

(a) (i) The name chlorofluorocarbons was well known by most candidates, however some referred to carbon chlorides or carbon fluorides.

(ii) Many candidates did not use sufficient precision with their answers and just referred to sunlight or rays from the sun rather than ultra-violet light. The link between ultra-violet and skin cancer was well known.

(b) (i) Candidates often only referred to a reaction that takes place in the presence of light and did not state the importance of having the light present. The best answers referred to reactions that only took place in the presence of light.

(ii) Many candidates gave the equation $2O_3 \rightarrow 3O_2$, although the equation $O_3 \rightarrow O_2 + O$ was also given credit. Weaker candidates had equations which involved electrons either initiating the reaction or being lost.

(c) Candidates found this equation demanding to balance and only the strongest candidates were successful. Incorrect answers often balanced the equation using $3Fe^{2+}$ rather than $2Fe^{2+}$.

Question A4

(a) Many candidates could draw a suitable, labelled diagram of the metallic bonding in copper. Some candidates did not label their diagrams with sufficient accuracy, for example just drawing circles with positive and negative signs. A common error was to label the positive particles as protons or as nuclei.

(b) Candidates often referred to atoms or ions sliding easily as opposed to layers of atoms or ions sliding. Some candidates described the meaning of malleability rather than giving an explanation as to why copper is malleable.

(c) (i) The best answers showed exactly how the percentage of 57.7% was calculated. However some candidates failed to account for the two copper atoms in the formula. Some candidates could not calculate the relative formula mass for $CuCO_3.Cu(OH)_2$.

(ii) Only the strongest candidates could describe a test for the carbonate ion. A common error was to use an alkali and see the colour of precipitate formed rather than use an acid and test for the presence of carbon dioxide using limewater.

(d) Candidates often found it difficult to interpret the ionic equations in terms of electron loss and electron gain and as a result failed to correctly identify the processes as oxidation or reduction.

Question A5

(a) Many candidates used the term diffusion in their answer but often used the bulk properties of the gases rather than the kinetic particle theory to explain the results. Candidates often referred to ammonia being lighter than hydrogen bromide rather than the molecular mass of ammonia being less than that of hydrogen bromide.

(b) Candidates often quoted Boyle's law rather than explaining in terms of the kinetic particle theory. Many candidates referred to the molecules being compressed rather than the distance between particles getting smaller.

Question A6

(a) Many candidates could calculate the energy released as 17.1 kJ. Those candidates that did not get this answer often calculated an incorrect relative formula mass for sodium hydroxide. A common error was to use a ratio based upon mass rather than moles.

(b) Good answers showed the working out to calculate the volume of $0.3\,dm^3$ or $300\,cm^3$. Weaker candidates did not show any clear working out which made the award of error carried forward credit impossible. These candidates often did not convert the mass into moles before attempting to work out the volume.

(c) The best answers gave the test for chloride ions using nitric acid and silver nitrate with the formation of a white precipitate. Some candidates forgot to use the nitric acid but this still allowed a credit to be given for the formation of a white precipitate. There were instances where candidates incorrectly tested for chlorine rather than chloride ion.

(d) The term amphoteric was known by some candidates although a significant proportion of the candidates did not give an answer.

Section B

Question B7

(a) Some candidates described the layers in boron nitride being held together by weak forces which allowed the layers to slide easily. Incorrect answers often referred to atoms sliding easily or to weak covalent bonds between the layers.

(b) Many candidates correctly calculated the number of protons and neutrons in the isotope of boron.

(c) Candidates often referred to the presence of covalent bonds but did not always describe these bonds as being strong and part of a giant lattice. A common error was to refer to strong forces between bonds or between molecules.

(d) (i) Most candidates gave a good explanation of why graphite conducts electricity.

(ii) The idea that graphite was inert or would not react with the electrolyte was stated by some candidates but others ignored the comment about other properties in the question and wrote about melting point or electrical conductivity.

(e) (i) Some candidates completed the equation but a common error was to give the incorrect number of electrons.

(ii) Candidates found this free response question more challenging than the equation in **(e)(i)**. The most common inaccuracy was to have the electrons on the wrong side of the equation being lost rather than gained.

(iii) Good answers described the molar ratio of hydrogen to oxygen or used the equations to state that 1 molecule of oxygen is associated with 4 electrons but 2 molecules of hydrogen is associated with 4 electrons. A common error was to give a ratio of hydrogen to oxygen without stating what type of ratio it was.

Question B8

(a) (i) Only the most able candidates were able to give a full explanation of why magnesium was in excess. Many candidates just calculated the amount in moles of hydrochloric acid, 2×10^{-3}, and of magnesium, 1.25×10^{-3}. Weaker candidates failed to use the mole ratio when working out which reagent was in excess.

(ii) The best candidates gave a description of the observation such as gas bubbles while other candidates just stated the identity of the product which was already given in the equation.

(b) Candidates found this question quite challenging with only the most able candidates able to deduce that 0.001 moles of hydrogen was made and hence 0.002 g of hydrogen was produced. Many candidates did not take into account that the volume in the graph was in cm^3 and gave an answer of 1 mole. Other candidates did not appreciate that because hydrogen is diatomic the relative formula mass is 2.

(c) Candidates often realised that the surface area was increased but often did not link this to an increased collision frequency.

(d) (i) Candidates found this equation very demanding and even if the formulae were correct candidates often got the state symbols incorrect. Typical errors included having Mg_2 and N.

(ii) Candidates often showed the formula of the nitride ion, N^{3-}, rather than just stating the charge as –3.

Question B9

(a) Candidates were often able to explain both the motion and arrangement of particles in a solid. Typical answers referred to particles vibrating about a fixed position.

(b) (i) Most candidates recognised the polymer as a condensation polymer.

(ii) Candidates found this question very demanding. The best answers showed all the atoms in the repeat unit. Typical errors included having the continuation bonds and the ester linkage reversed in one of the repeat units.

(c) (i) Good answers showed clearly how the answer of 2052 g was calculated. Many candidates were only able to calculate the relative formula masses while other candidates only used the percentage yield part of the calculation.

(ii) Many candidates gave very good definitions and showed good knowledge of this area.

Question B10

(a) The best answers appreciated that the position of equilibrium moves to the right because there is a smaller number of moles on the product side of the reaction. Some candidates described the effect on the rate of reaction and others stated that the position of equilibrium remained the same because the temperature was constant.

(b) The best answers appreciated that the position of equilibrium moves to the right because the forward reaction is exothermic. Some candidates described the effect on rate of reaction rather than the position of equilibrium.

(c) Many candidates found it difficult to describe the effect of decreasing the temperature rather than increasing the temperature on the rate of reaction. The idea of the particles having less kinetic energy or moving slower was poorly expressed and many candidates only referred to a decrease in collision frequency and did not mention successful collisions.

(d) (i) Candidates often gave good answers describing the increase in rate of reaction and the lowering of the activation energy.

(ii) Candidates often gave one property of a transition element but rarely gave two correct properties. Typical weaker answers described copper as coloured rather than copper having coloured compounds.

CHEMISTRY

Paper 5070/22

Theory

Key Messages

To be successful in calculations candidates must organise their answers in a clear and coherent way making certain that the working out is clearly shown.

Candidates should ensure they are confident of key definitions.

Candidates should be reminded to write with a clear focus on free response questions and to be sure to give answers which are not vague or off topic.

General comments

While the rubric was interpreted well, candidates often did not read the stems of various questions carefully enough and made errors due to this.

Many candidates performed well in questions involving calculations, showing appropriate working, clear progression in each step of the calculation and clear indications as to what each number referred. Other candidates gave no explanation of what they were doing or the relevant units e.g. grams or moles. This often meant that credit could not be given for working out.

Some candidates' knowledge of structure and bonding was good. Others got confused between ionic and covalent structures, often referring to molecules and intermolecular forces when discussing the structures of diamond and silicon dioxide. Many tried to explain ionic conduction in terms of movement of electrons.

Many candidates need more practice in writing the formulae of esters and condensation polymers. Other aspects of organic chemistry were generally well answered although some candidates need to distinguish the difference between observations e.g. in the test for unsaturated compounds and the feature of unsaturated molecules e.g. C = C double bond. The writing of balanced equations was not always successful, a major obstacle for some candidates being to work out how to construct ionic equations.

Many candidates answered equilibrium questions in terms of rate of reaction and referred to equilibrium in questions involving rate of reaction. Candidates generally need more practice in interpreting whether the question relates to one or other of these topics. Many candidates also need practice at answering questions involving the strength of acids and relate this to the frequency of collisions of hydrogen ions when acids of different strength react.

Some candidates were able to define electrolysis and relative atomic mass correctly. Many others wrote definitions which were too vague or irrelevant.

Comments on specific questions

Section A

Question A1

(a) Many candidates identified iron correctly. The most common error was to suggest 'copper' by focussing on the red-brown colour and forgetting that there was a reaction with sodium hydroxide.

(b) Few candidates gave iodine as the correct answer. Many gave "nitrogen" as the answer because they had focused on the words "five" and "electron" rather than taking the word "shells" into account.

(c) Many candidates identified sulfur (dioxide).

(d) This was the best answered part of this question.

(e) Some candidates recognised the fact that argon is an inert gas. Others did not realise that the word "atmosphere" indicated that the answer required the name of a gas and hence incorrect answers such as zinc or magnesium were often seen.

(f) This was only answered correctly by the strongest candidates. Most candidates gave the incorrect answer, nitrogen, by incorrectly focusing on the nitrogen in ammonia rather than considering the test for a nitrate.

Question A2

(a) Many candidates wrote the symbol equation correctly. Others gained partial credit from an unbalanced equation or a word equation. Some candidates confused photosynthesis with respiration and wrote the equation for the latter. Others included carbon dioxide as a product with glucose being the sole reactant. A significant number of candidates omitted chlorophyll.

(b) (i) The correct answer was often given. Common incorrect answers included glycogen, ethanol or reference to fermentation.

(ii) Few candidates knew the conditions for the hydrolysis of complex carbohydrates such as starch. Only the strongest candidates realised that an acid was the necessary reagent with most giving a variety of other compounds. A few realised that the hydrolysis could be carried out using enzymes but many candidates suggested catalysts used in other processes e.g. vanadium(V) oxide or nickel. A considerable proportion of candidates did not respond to this question.

(c) (i) Some candidates identified calcium ethanoate correctly. Others gave answers such as calcium ethanoic acid. Calcium hydroxide was a common incorrect answer.

(ii) Few candidates drew the correct structure of a suitable ester. The most common errors were to draw a carboxylic acid, omit an oxygen atom from the ester linkage or insert a hydrogen atom in the ester link. Many candidates drew five-valent carbon atoms.

(iii) Many candidates gained full credit for the calculation of the empirical formula. Weaker answers inverted the first part of the calculation e.g. 12 / 37.5 rather than 37.5 / 12, or used one or more molecular masses instead of atomic masses.

Question A3

This was the most challenging question in **Section A**. Many candidates knew the roles of carbon and chlorine in water treatment. Fewer knew what is meant by 'desalination' and even fewer could identify the anions which are responsible for eutrophication.

(a) This part was well answered. More candidates knew the role of chlorine in water treatment than the role of carbon. Many thought that carbon removed bacteria. Others gave vague answers such as "removes impurities".

(b) Some candidates gave the straightforward answer "removal of salt", which was all that was required. Others gave the names of processes or described processes such as distillation or reverse osmosis without giving the essential feature of desalination.

(c) Few candidates gave nitrate and phosphate as an answer. Many gave the names of the elements, nitrogen or phosphoorus, rather than the ions, though the most common incorrect answer was sulfate.

(d) Most candidates did not write a balanced ionic equation. Some wrote the correct ions but added other ion or molecules as products. A few of these candidates were able to gain partial credit for the correct state symbols related to specific ions. The most common errors were to write molecular equations, to show Ba with a single positive charge or to write ions such as $H_2SO_4^{2-}$. Many candidates did not write state symbols. The most common of the state symbol errors was to write either $BaSO_4$(aq) or SO_4^{2-} (l).

Question A4

This was the best answered of the **Section A** question with many candidates giving good answers to most parts.

(a) (i) Many candidates balanced the equation correctly. Others either did not read the correct product in the stem of the question and gave carbon dioxide as a product or gave an incorrect balance with 2C on the left.

(ii) The strongest candidates balanced the equation correctly. Others either did not write the correct formula for iron(III) oxide in the stem of the question or wrote iron as Fe_2. Apart from these, the most frequently seen errors arose from incorrect balancing or addition of extraneous substances such as hydrogen or water as products.

(b) Many candidates mentioned removal of impurities but without qualification and so could not gain credit. Common correct answers referred to the formation of slag or removal of acidic impurities. Few candidates mentioned that the limestone first had to decompose.

(c) The calculation of percentage by mass was done well by a majority of candidates with clear working out evident. Weaker responses included errors which arose from not multiplying the atomic mass of iron by three or from the incorrect calculation of the formula mass of iron(III) oxide.

(d) Many candidates produced good answers by relating the equations to both oxidation and reduction in terms of electron transfer. Those who decribed the removal or addition of oxygen or hydrogen or wrote about oxidation number changes did less well. Many candidates identified the element which was undergoing oxidation number change incorrectly e.g. "the oxidation number of hydrogen increases".

(e) The idea of sacrificial protection was known by many candidates. Most candidates gained credit for the idea that magnesium is more reactive than iron. A significant number of candidates did not gain full credit however because they suggested that either magnesium rusts or that magnesium forms a layer covering the surface of the iron.

(f) Many candidates were able to construct the simple equation. Common errors were to suggest water as a product, to write the formula for iron(II) chloride as $FeCl$, to write the formula for HCl as HCl_2 or to leave the equation unbalanced. It was fairly common to see Fe_2 written as the symbol for iron.

Question A5

(a) (i) Many candidates answered this part of the question very well, often using the word 'diffusion' or giving some indication that the (bulk) movement of the gases is from high to low concentration. Many did not use the idea of particles to explain the random movement or the mixing of gases. Candidates should be advised that the word "particle" or "molecule" should be used when questions ask for an explanation in terms of the kinetic particle theory.

(ii) A wide variety of answers were seen, many not related to relative molecular mass. The most common errors were to write about differences in gas density or 'masses of the gases'. Others did not gain credit because they wrote about atomic masses.

(b) Some candidates knew that the molecules move faster at higher temperature but few gave a suitable answer in terms of the particles getting further apart. Once again, candidates should be advised that the word "particle" or "molecule" should be used when questions ask for an explanation in terms of the kinetic particle theory. Some candidates wrote about Charles' Law or tried to answer the question in terms of frequency of collisions.

Question A6

(a) Many candidates calculated the energy released correctly. The most common errors were to calculate the number of moles incorrectly or to overcomplicate the working by reducing to 1 g and then trying to multiply up in a series of stages. A small number of candidates gave the incorrect units.

(b) Some candidates balanced the equation correctly. Others made simple errors such as putting a negative charge on SO_2 or leaving the charge off OH^-.

(c) Only the strongest candidates gained full credit. Many thought that ethanoic acid was a strong acid. Few referred to concentration of hydrogen ions or to frequency of collisions. Many just reversed the stem of the question by writing that ‘ethanoic acid is stronger than the hydrogensulfite ion’.

(d) Some candidates were able to calculate the correct number of moles of sodium hydroxide. Others did not understand how to rearrange the equation relating concentration to moles and volume to make volume the subject and multiplied the number of moles by the concentration.

Section B

Question B7

(a) Many candidates gave a suitable point of similarity between the structures of diamond and silicon dioxide. The most common correct answer referred to the tetrahedral arrangement of the atoms. Many errors arose through vague answers such as ‘”they are big structures” or incorrect answers such as “they both contain carbon atom”. A number of candidates referred to covalent bonding. This was not given credit because the question specifically asks for the structural similarities.

(b) Many candidates gained partial credit for the idea that the bonding is strong. However few gained full credit for including the idea that there are lots of bonds or that silicon dioxide is a giant structure. A number of candidates penalised themselves by writing about “strong intermolecular forces”.

(c) A minority of candidates were able to deduce the structure of the silicate ion. The most common errors were to give an uncharged species or to give an incorrect formula, SiO^{2-} or SiO_3^- being commonly seen.

(d) Most candidates referred to mobile, delocalised or free electrons. Few wrote about mobile ions.

(e) A minority of candidates gave a convincing definition of electrolysis. Common errors were to omit either the ideas of decomposition/breakdown or omit the idea that an electric current was involved. A major error was to suggest that electrolysis is a separation method. Although the products may be able to be collected independently, the idea of separation by electricity refers to electrophoresis and not to electrolysis.

(f) (i) A minority of the candidates gave the correct equation for discharge at the anode during electrolysis of aluminium oxide. The most commonly seen error was to suggest that hydroxide ions were the source of the oxygen. Other errors included incorrect balancing using electrons, the electrons on the incorrect side of the equation or incorrect species such as 2O or O_2^-. A significant number of candidates wrote the aluminium ion-electron equation here.

(ii) Many candidates wrote the ion-electron equation correctly. The commonest errors were to write $3Al$ on the right or to write $Al^{3+} + e^-$ on the left.

(g) Most candidates deduced the number of protons and neutrons in a silicon-29 atom correctly.

(h) Very few candidates were able to define relative atomic mass adequately. Many used the word substance or molecule or element instead of atom or omitted the comparison with carbon-12. Most defined mass number.

Question B8

(a) Some candidates correctly calculated moles of NaOH or Cl_2 but many just calculated the value for one of these and then tried to use the mole ratio of two to calculate the value of the other without taking the initial amounts into consideration. Those who did calculate the values of both NaOH and Cl_2 correctly often did not gain full credit because the mole ratio was not taken into consideration. Some ingenious methods of calculating the volume or mass of Cl_2 required to react with the available sodium hydroxide were given credit. A significant number of candidates did not respond to this part.

(b) (i) While there were some good answers to this question, there were a number of weaker responses.There were instances of the incorrect formulae given for the halogens e.g. 2C*l* rather than Cl_2 or not balancing the halides in the equation.

(ii) Some candidates compared the reactivity of chlorine and bromine correctly. Others compared bromine with chloride or even potassium.

(iii) Most candidates gave the correct charge for the chloride ion. A few weaker candidates suggested an electron configuration of 2, 8, 7.

(c) Many candidates could explain ionic conduction although a significant number thought that the conduction was due to the movement of electrons.

Question B9

(a) Many candidates described a suitable test for an unsaturated hydrocarbon. The most common errors were to suggest using sodium hydroxide or to state that unsaturated hydrocarbons have a double bond. A significant number of candidates thought that the bromine water would remain reddish-brown.

(b) Many candidates gained partial credit on this question. However, many did not understand the difference between arrangement and proximity of the particles and described the particles as being close together or, more often, some way apart, rather than how they are arranged. Candidates were generally more secure describing the motion of the particles.

(c) Many candidates were able to calculate the mass correctly. Weaker answers gave incorrect calculations of molar masses or incorrect calculation of the moles of isoprene. A significant number of candidates did not respond to this part.

(d) (i) Some candidates recognised that the addition polymers are derived from monomers which have double bonds. Others referred to CH_3 groups or did not refer to the molecule at all e.g. "they add together to form the polymer". A significant number of candidates did not respond to this part.

(ii) A wide variety of monomer structures were seen. Many had extension bonds but the C=C double bond was often absent. Many answers either showed a repeat unit with the extension bonds and no C=C bonds or a section of the polymer showing three carbon atoms in line with or without the C=C bond. A significant number of candidates did not respond to this part.

Question B10

(a) Some candidates gained partial credit for the correct change in position of equilibrium. Others suggested that the equilibrium went to the left. Many candidates gave incorrect reasons based on collision theory and reaction rate rather than referring to the relative number of moles/volumes of gases in the equation. Some candidates gave incorrect answers referring to 'more particles being present in the products' without reference to the equation.

(b) While some candidates produced a relevant answer for the correct change in position of equilibrium, others suggested that the equilibrium went to the left. Many candidates gave incorrect reasons based on collision theory and reaction rate rather than referring to the reaction being exothermic.

(c) (i) Candidates found this part challenging. Some candidates did not distinguish between PCl_3 and PCl_5 and just wrote about the percentage of the phosphorus chloride increasing. Others did not mention the direction of change in temperature e.g. 'the concentration of PCl_3 increases with temperature'.

(ii) Many candidates gave vague answers with some not referring to energy at all. Many thought, incorrectly, that the energy change was endothermic. A significant number of candidates did not respond to this part.

(d) Many candidates commented on rate but fewer made a correct statement about the equilibrium position. Of those who did make comments about the position of equilibrium, many suggested that the position of equilibrium moved to the right.

(e) Many candidates realised that the molecules had more energy. Fewer gave an adequate explanation in terms of activation energy or increasing number of successful collisions.

(f) Many candidates did not recognise the formula for phosphorus(V) chloride despite the fact that it had been given in the stem of the question. Others tried to balance the equation unsuccessfully using two moles of phosphorus(V) chloride.

CHEMISTRY

Paper 5070/31
Practical Test

Key messages

Candidates should be reminded of the need to check their work and to record the results of their observations accurately.

General comments

Candidates generally proved themselves to be well prepared and showed themselves capable of dealing with the titration both in terms of the technique and the processing of their results. Qualitative tests were completed but the observations provided were often incomplete and at times incorrect.

Comments on specific questions

Question 1

(a) Candidates obtained full credit for their titration results by recording initial and final burette readings to 1 or 2 d.p., obtaining at least two titres within 0.2 cm^3 of the Supervisor's value and then correctly averaging two or more ticked results that did not differ by more than 0.2 cm^3.

There were many who produced accurate and consistent titration results and only a few who wasted time carrying out unnecessary extra titrations. Nevertheless, some candidates made careless errors either by not ticking the best results or by averaging all their titres despite having only ticked some.

While only a few gained full credit for this part, there were many candidates who demonstrated competence and gained partial credit. Clear working was generally in evidence.

(b) Most candidates provided the correct answer or showed the appropriate working. However, there were some who found using the volume and concentration of the solution **Q** to determine the number of moles of the alkali challenging.

(c) The 1:1 ratio in the equation was correctly used and so many supplied the answer from **(b)**.

(d) Scaling from the titre to 250 cm^3, in order to calculate the number of moles of acid, proved problematic for many candidates but it was competently managed by stronger candidates.

(e) Those who had completed **(b)** well generally repeated their success here.

(f) In general those who had obtained good answers in **(d)** and **(e)** carried out the subtraction correctly. There were a few candidates who incorrectly added the answers together.

(g) Most of the candidates with an answer in **(f)** obtained a mark in **(g)** by multiplying by 100. There were a few who divided the answer by 2 either to take into account the number of tablets or the stoichiometry of the equation but it was rare to find the correct mass of calcium carbonate calculated.

Question 2

Many candidates were not consistent in their carrying out and reporting of the tests in this question. It is important that instructions are carefully followed e.g. a gas when produced should be tested and named. Observations must be recorded correctly and accurately using appropriate terminology. Candidates should be encouraged to make full use of the Qualitative Analysis Notes supplied on the last page of the question paper booklet.

R was dilute hydrochloric acid. **S** was manganese(IV) oxide.

Test 1

Virtually all candidates reported that a reaction took place but descriptions referring to the solution turning white, milky or cloudy received no credit.

Test 2

Most of the candidates recognised that the white solid formed in **Test 1** remained when acid was added.

Test 3

A number of candidates were unable to get the precipitate from **Test 1** to dissolve in aqueous ammonia. It may be that they need encouragement to agitate the mixture more and/or to add excess of the reagent. Generally those who noted the solid disappeared also described the final solution as colourless.

Test 4

Bubbles was the most recorded observation in **(a)** but only the stronger candidates indicated that they tested the gas and then fewer still named the gas identified. It may be that those candidates who recorded "a gas evolved CO_2" saw bubbling and tested the gas but without recording any evidence, no credit could be given.

In **(b)**, it was expected that by naming the metal in the carbonate as zinc, this would lead candidates to the observation that a white ppt formed which dissolved in excess alkali to form a colourless solution. It was rare to find the observation that the solid was soluble in excess and a considerable number of candidates were unable to produce any precipitate with the alkali.

Test 5

Most candidates reported a white precipitate in **(a)** and noted that the solid disappeared in **(b)**. Contradictory observations however were found e.g. "a white insoluble solution", "clear white solution", "clear colourless precipitate" suggesting a poor grasp of the terminology.

Test 6

As with Test 4 there were many who noted the bubbling on addition of **S** but few candidates who went on to identify and name the gas evolved.

Test 7

Some were confused by the term filtrate in **(b)** believing it to be the solid rather than the liquid from **(a)**. Nevertheless, many candidates tested their iodine-containing liquid in **(b)** with starch solution and correctly recorded that the liquid turned black and/or blue.

Test 8

While the bleaching of the litmus paper was noted, not all identified the gas as chlorine.

(b) Conclusions

Only the strongest candidates identified the compound in **R** as hydrochloric acid although some others indicated that the solution contained chloride ions.

The most popular response for **S** was that it acted as a reducing agent. The production of iodine and/or chlorine provided the evidence for it being classed as an oxidising agent.

CHEMISTRY

Paper 5070/32
Practical Test

Key messages

Candidates should be reminded of the need to check their work and to record the results of their observations accurately.

General comments

Candidates generally proved themselves to be properly prepared and they completed the paper in the time available. While the titration part of **Question 1** was carried out successfully by most candidates, the calculations proved problematic for a variety of reasons. With the qualitative chemistry, there were a number of candidates who could have been more consistent in their execution and reporting of the tests.

Comments on specific questions

Question 1

(a) Candidates obtained full credit for their titration results by recording initial and final burette readings to 1 or 2 d.p., obtaining at least two titres within 0.2 cm^3 of the Supervisor's value and then correctly averaging two or more ticked results that did not differ by more than 0.2 cm^3.

There were many who produced strong answers. While most candidates were well trained in how to complete the table of results, there were a few who made errors such as using 50.0 for the initial reading, ticking only one or none of the titration results, calculating the average using all the values despite ticking only some and recording the total volume of **Q** used in all the titrations completed instead of the volume of the pipette.

While only a few gained full credit for the calculations that followed, there were many candidates who demonstrated competence and gained partial credit. Clear working was generally in evidence. There were numerous examples of the use of 24 dm^3: confusion of molar volume of a gas and concentration of a solution was clearly a problem for some candidates. In addition there was some careless transcription of numbers e.g. missing or reversing digits, misplacing the decimal point.

(b) Most candidates provided the correct answer or showed the appropriate working. However, there were some who found using the concentration of **Q** in mol/dm^3 and the volume of **Q** in cm^3 challenging and this problem usually recurred in **(f)**. A few used the average volume of **P** instead of the volume of **Q**.

(c) The 1:1 ratio in the equation was recognised by most and the answer from **(b)** was successfully supplied.

(d) This calculation proved problematic with some candidates producing answers smaller than that in **(c)** and others answers in excess of 0.1. Nevertheless, there were many candidates who knew how to scale the number of moles from **(c)** to that in a 110 cm^3 of solution. Unfortunately, some of these chose to use the volume of **Q** used in **(b)** again rather than the average titre of **P**.

(e) There were a large number of correct answers for this part.

(f) The need to subtract **(d)** from **(e)** was not widely recognised and it was common to find the numbers of moles being added together or even divided or multiplied.

(g) Most of the candidates with an answer for **(f)** obtained a mark in this part, usually by multiplying by 58. There were some who correctly scaled the volume from 10 cm^3 to 1 dm^3 but relatively few who realised the need to divide the number of moles of acid by 2 in order to determine the number of moles of magnesium hydroxide.

Question 2

Candidates who followed the test instructions consistently and provided complete and precise observations, produced strong answers in this question. Candidates should be encouraged to make full use of the Qualitative Analysis Notes supplied on the last page of the question paper booklet.

R was dilute sulfuric acid. **S** was copper(II) oxide.

Test 1 Virtually all candidates gained full credit for reporting a white precipitate in **(a)** which did not dissolve when the acid was added in **(b)**. A small number of candidates recorded the formation of a white, milky or cloudy solution and so did not gain the mark in **(a)**.

Test 2 In **(a)** bubbling was frequently noted and while the gas was usually correctly tested, it was not always identified. The disappearance of the magnesium was often missed. The addition of aqueous sodium hydroxide in **(b)** generally produced the observation of a white precipitate (in a few cases it was yellow presumably because of contamination from the burning splint used in testing the hydrogen) but not many noted the solid's insolubility in excess alkali.

Test 3 Despite the instruction to warm until the liquid disappeared, a number of candidates reported the final liquid to contain a blue precipitate.

Test 4 The production of a blue precipitate on addition of aqueous ammonia was missed by a considerable number of candidates who, as a result, were unable to gain full credit.

Test 5 While any indication of the colour of iodine and the presence of a precipitate in **(a)** was credited, there were some observant candidates who reported that it was the liquid that was yellow/brown and not the precipitate. The addition of the sulfite in **(b)** reduced the iodine so the colour was discharged and a white precipitate remained. Many candidates secured full credit but there were some who had difficulty in distinguishing between precipitates and solutions.

Test 6 Bubbling at some stage of the test was noted by virtually all candidates and there were many who went on to test the gas correctly with a glowing splint and identify it as oxygen.

There was, however, much confusion evident in the observations for this test. In **(a)** there is little or no reaction when the solid is added to the hydrogen peroxide. A few bubbles might be seen but it is unlikely enough oxygen is produced to relight a glowing splint. While the added solid is insoluble, there is no black precipitate formed. In **(b)** the addition of aqueous ammonia causes rapid decomposition of the hydrogen peroxide and, consequently, much effervescence of oxygen. Many candidates believed the gas evolved to be ammonia. It is important that candidates recognise that aqueous ammonia smells of ammonia and, therefore, will always give a positive test for the gas.

(b) Conclusions

The cation in solid **S** was correctly identified as copper(II) or Cu^{2+} by many candidates. Sulfate or SO_4^{2-} was correctly linked to solution **R** but relatively few suggested the compound present in the solution was sulfuric acid.

CHEMISTRY

Paper 5070/41
Alternative to Practical

Key Messages

In questions involving one or more calculations, candidates should be reminded to show all of their working. When the number of marks for a calculation is greater than one, it is an indication of its difficulty. In such cases one or more of the marks will be for the working. If no working is shown, and the answer is incorrect, it is not possible to award any marks for it.

When candidates are asked to draw a graph they should follow the instructions in the question with regard to drawing a curve or a set of straight lines through all the points. The line should be extended where appropriate to pass through zero. It should be noted that this is only required when the line, on extension, would naturally pass through zero.

General comments

The Alternative to Practical Chemistry paper is designed to test the candidate's knowledge and experience of practical chemistry. Skills assessed include recognition and calibration of chemical apparatus and their uses, recall of experimental procedures, handling and interpretation of data, drawing of graphs, analysis of unknown salts and calculations.The majority of candidates show evidence of possessing many of the aforementioned skills.

Comments on specific questions

Question 1

(a) Most candidates correctly named the alcohol and knew that the aluminium oxide acted as a catalyst.

The double bond was often missing in the structure and sometimes when a double bond was present a carbon atom had more than four bonds.

(b) The test for unsaturation using aqueous bromine was well known.

(c) Many candidates correctly identified the gas and the limewater test was well known.

The equation for the complete combustion of propene was often not balanced correctly but partial credit was given if all the species were correct.

Question 2

(a) The identity of the gas was generally correct but some confused the test for hydrogen using a lighted splint with that for oxygen were a glowing splint is used.

(b) Many candidates correctly identified chlorine as the product at the positive electrode but the ionic equation often showed the production of chlorine atoms or had the addition of electrons on the wrong side of the equation.

(c) The name of the gas and the test were generally correct but again the ionic equation proved challenging.

Question 3

Most candidates knew that a more reactive metal displaces a less reactive metal and were able to deduce the tubes in which a reaction would occur.

Question 4

This question was well answered. The percentages are divided by the relative atomic masses and the simplest ratio is then found.

Question 5

Many candidates failed to recognise that **(a)**, **(b)** and **(c)** produce precipitates and are reactions commonly used in the identification of ions.

Question 6

The use of a volumetric flask to make up solutions was not well known but most candidates knew that a pipette was used to transfer the solution to the conical flask and that the colour at the end-point would be pink or purple.

When errors occur in reading the burette diagrams or subtracting the volumes the mean must be taken from the closest two titres. A common error was to use all three titres in calculating the mean.

In the calculations errors are carried forward so that candidates are given credit for correct chemistry even if an error has been made in an earlier part.

In **(i)** many candidates did not use their answer to **(h)** but simply divided the M_r of water by that of oxalic acid.

Question 7

(a) A coloured solution indicates that a transition metal ion is present in compound **Z**. Candidates who stated that **Z** or 'it' is a transition metal did not gain credit.

(b) The reaction of copper(II) ions with sodium hydroxide was well known.

(c) Most candidates gained partial credit for the production of a blue precipitate but many stated that on the addition of excess ammonia the precipitate turned dark blue or was simply soluble without stating that a deep blue solution was formed.

(d) The test for chloride ions was well known. Weaker candidates gave incorrect answers either not using silver nitrate or using hydrochloric acid.

(e) The formula of compound **Z** was generally correct.

Question 8

(a) A common error was to state that the sodium hydroxide was allowed to stand for a few minutes so that it could settle rather than so it could reach room (or a steady) temperature.

(b) A significant number of candidates confused exothermic and endothermic reactions.

(c) Weaker candidates did not recognise that temperature begins to decrease because all the sodium hydroxide had reacted and the acid was in excess. These candidates often incorrectly stated that all the acid had reacted.

(d) Candidates were given credit for plotting the points accurately and joining them with two intersecting straight lines as stated in the question. Most candidates did this well although some incorrectly drew a curve or a series of straight lines.

(e) Most candidates correctly read the answers from their own graph.

(f) Many candidates had an incorrect mole ratio in the equation but credit could be given for the calculation based upon this ratio. Partial credit was given in the calculation for correctly calculating the number of moles of each reagent that reacted.

(g) Most candidates correctly calculated the temperature change by subtracting 24.2 from their answer to **(e) (ii)** but many repeated their answer to (**e) (i)** as the final volume, neglecting to add the volume of sodium hydroxide already in the beaker.

The calculation in **(e) (iii)** was well done with many candidates gaining full credit. Partial credit was given for correctly calculating the number of moles of sodium hydroxide used or for a correct calculation based upon an incorrect number of moles.

(h) Many candidates gained credit for heating the solution until it was saturated or crystallisation point was reached but some neglected to wash and dry the crystals. Candidates who evaporated the solution to dryness gained only partial credit as this would not produce crystals.

CHEMISTRY

Paper 5070/42
Alternative to Practical

Key Messages

In questions involving one or more calculations, candidates should be reminded to show all of their working. When the number of marks for a calculation is greater than one, it is an indication of its difficulty. In such cases one or more of the marks will be for the working. If no working is shown, and the answer is incorrect, it is not possible to award any marks for it.

When candidates are asked to draw a graph they should follow the instructions in the question with regard to drawing a curve or a set of straight lines through all the points. The line should be extended where appropriate to pass through zero. It should be noted that this is only required when the line, on extension, would naturally pass through zero.

Many candidates continue to confuse the test for hydrogen with that of oxygen e.g. the presence of hydrogen is tested with a glowing splint which pops in a flame.

General Comments.

The Alternative to Practical Chemistry paper is designed to test the candidate's knowledge and experience of practical chemistry. Skills assessed include recognition and calibration of chemical apparatus and their uses, recall of experimental procedures, handling and interpretation of data, drawing of graphs, analysis of unknown salts and calculations.The the majority of candidates show evidence of possessing many of the aforementioned skills.

Comments on Specific Questions

Question 1

(a) Most candidates correctly identified the gas syringe though syringe was often spelt incorrectly.

(b) There was some confusion with the test for oxygen. Answers such as "burns with a pop" or "burns in a flame" were not accepted.

(c) This question was answered well with correct answers to all or most parts of the calculation.

(d) Only the strongest candidates answered this part correctly. Incorrect suggestions of impurity or contamination were seen rather than reference to copper being wet or containing moisture.

Question 2

(a) (i) Many candidates identified the reaction as an example of cracking. Thermal decomposition was often mentioned but this was not specific enough to be credited.

(ii) Most candidates correctly noted that aluminium oxide is used as a catalyst or speeds up the reaction.

(iii) Many candidates were able to provide the correct formula in this part.

(iv) There were several possible correct answers to this question which could be credited.

(b) The reaction between ethene and aqueous bromine was well known by most candidates. A common error was the suggestion that bromine turned brown.

(c) The evolution of carbon dioxide when ethene undergoes combustion in air was generally well known.

Questions 3 to 6

Most candidates gave correct responses to all or most of the multiple choice questions.

Question 7

(a) Most candidates were able to perform this subtraction.

(b) A volumetric or standard flask should be used rather than a beaker, measuring cylinder, round bottomed or conical flask all of which were suggested by weaker candidates.

(c) There were many good answers to this part.

(d) Most candidates noted the correct burette volumes. When errors occur in reading the burette diagrams or subtracting the volumes, the mean must be taken from the closest two titres. A common error was to use all three titres in calculating the mean.

(e) to (k) Many candidates were able to follow through the calculations giving correct answers using the correct number of significant figures.

A common error was an incorrectly balanced equation. This consequently introduced errors into the calculation although marks were awarded when an incorrect answer was used correctly in subsequent parts.

Question 8

(a) The test indicates that there are no transition metals or metal ions present in compound **L**. Answers such as **L** or 'it' is not a transition metal did not gain credit.

(b), **(c)** To gain full credit, answers needed to state the presence of a white precipitate which is either soluble **(b)**, or insoluble **(c)**, in excess of the reagent.

(d) Although this was answered correctly by many candidates, some candidates gave incorrect answers in which sulfuric acid or a sulfate was used in the test. Formulae, when used instead of names for any of the reagents, needed to be correct.

Question 9

(a) The equation must balance and include oxygen as O_2 not 2O. Several candidates gave an equation to prepare copper(I) oxide which did not gain credit.

(b) Nitrogen was correctly given by most candidates although oxygen was often suggested by weaker candidates.

(c) The graph was drawn correctly by most candidates. Common errors included failure to extend the line to pass through zero and attempting to draw a line to include the anomalous point. Some candidates did not circle the anomalous point and so did not answer **(iii)**. Very few candidates gave one of the accptable answers to **(iv)**.

Question 10

(a), (b) and **(c)** There were many good answers to these three parts of the question.

(d) To gain credit candidates needed to suggest that the initial solution needs to be heated in some way. The best answers recognised that the extent of heating is important in that all the water should not be removed. These answers usually recognised that a suggestion of a saturation point, a point of crystallisation or to leave some of the water was needed for further credit. Several candidates failed to state that the crystals should be both washed and dried.